



# ET Mapping using ALEXI for Drought Monitoring

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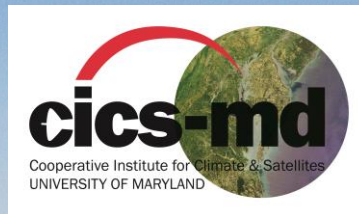
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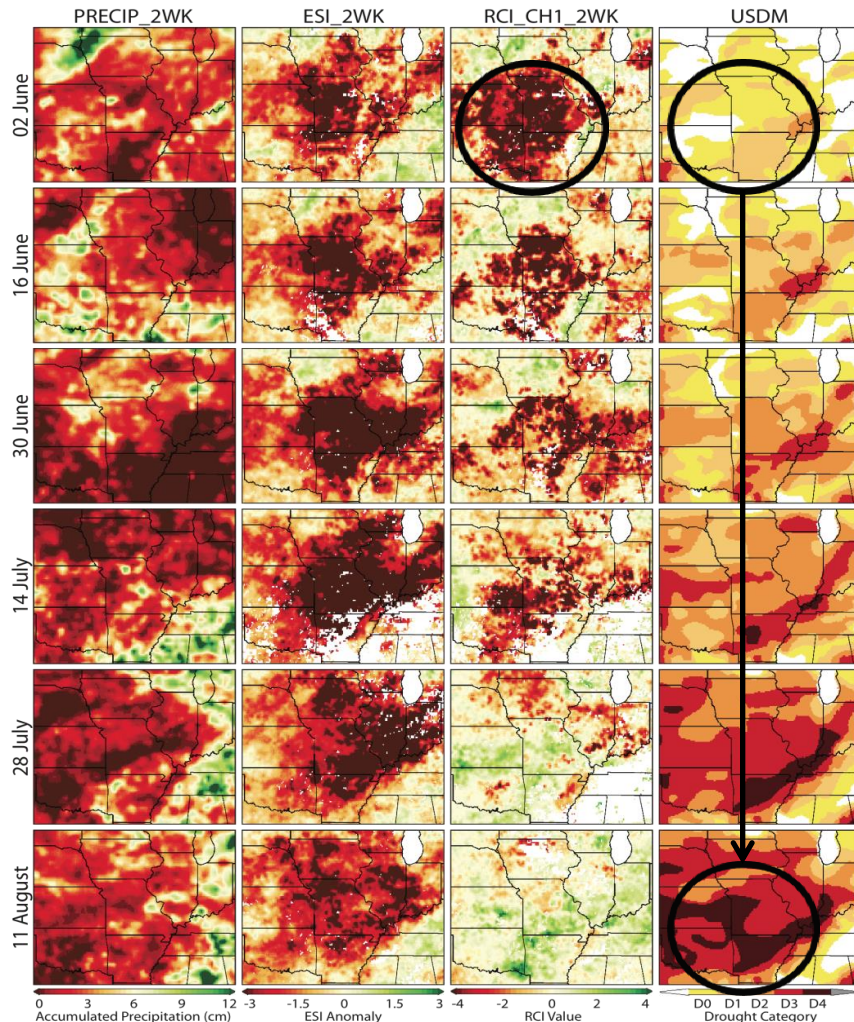


ALEXI ESI represents temporal anomalies in the ratio of actual ET to potential ET.

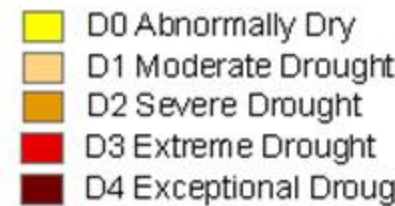
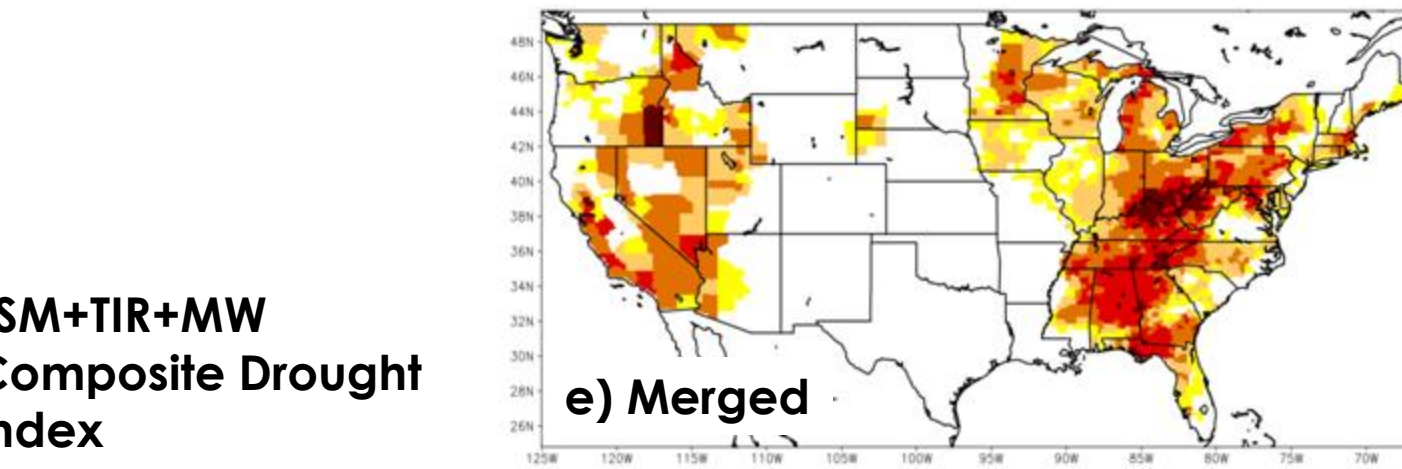
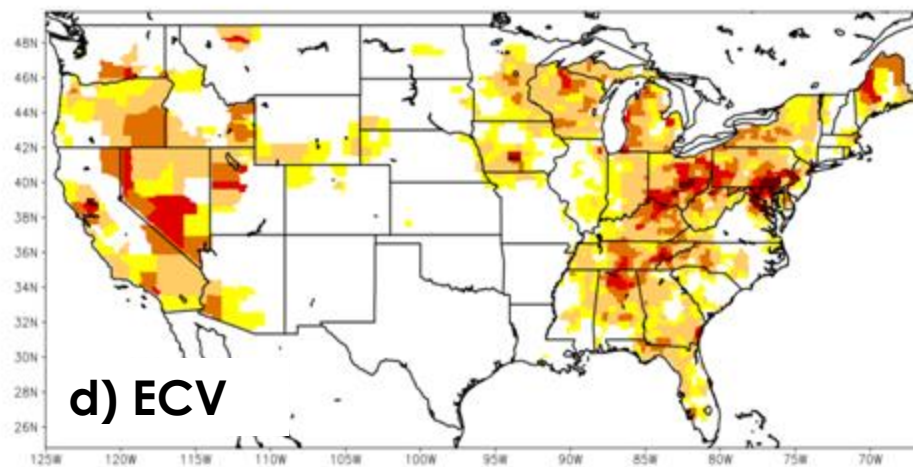
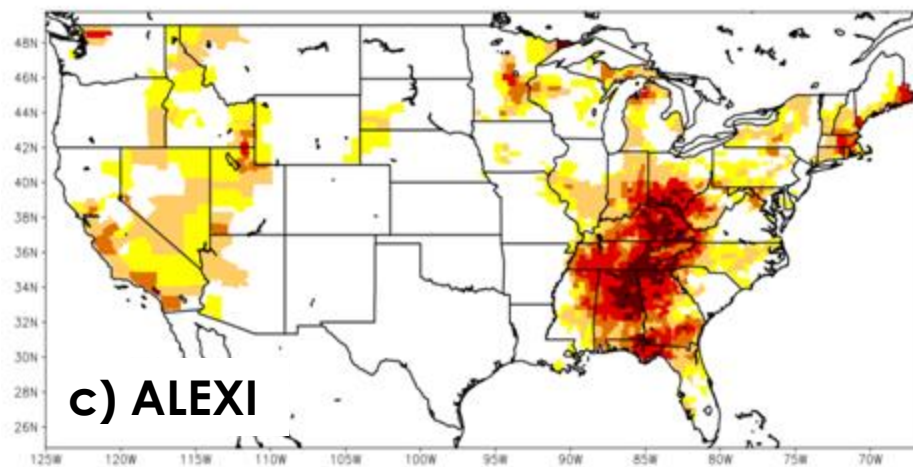
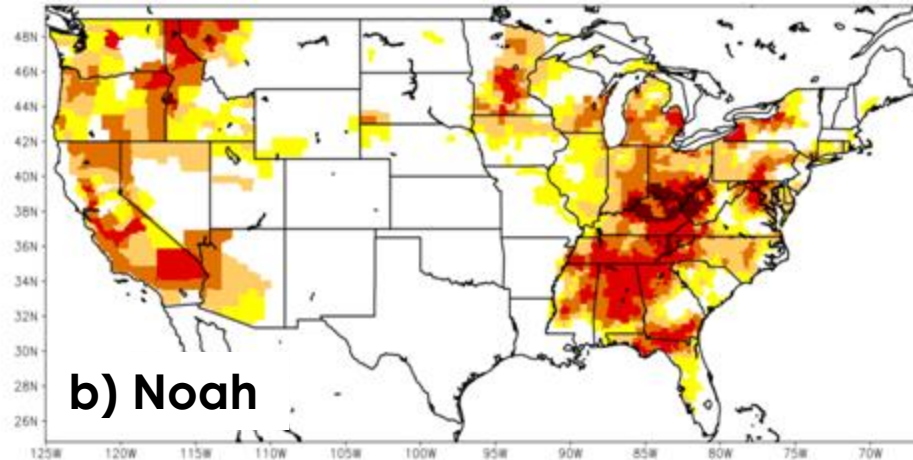
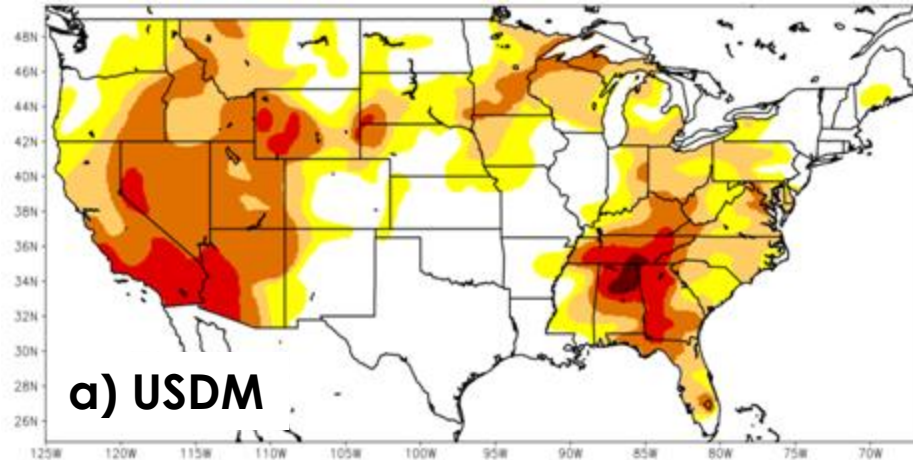
- ESI does not require precipitation data, ***the current surface moisture state is deduced directly from the remotely sensed LST***, therefore it may be more robust in regions with minimal in-situ precipitation monitoring.
- Signatures of vegetation stress are manifested in the LST signal before any deterioration of vegetation cover occurs, for as example as indicated in NDVI, so TIR-based indices such as ESI can provide an effective early warning signal of impending agricultural drought.
- ALEXI ESI inherently includes non-precipitation related moisture signals (such as irrigation; vegetation rooted to groundwater; lateral flows) that need to be modeled a priori in prognostic LSM schemes.
- ALEXI ESI provides an independent assessment of current drought conditions, supplementing precipitation and modeling-based indices – an invaluable resource to decision-makers who usually depend on a convergence of information in the decision making process.

# Central US Flash Drought of 2012

Flash drought are rapid onset events typically driven by precipitation deficits, high temperature anomalies and often strong winds. ESI has the potential to provide an early warning component during such events as water stress is able to be detected in the LST signal before degradation in the vegetation health occurs.



- Large negative RCI values in the top row indicate that moisture stress was rapidly increasing at the beginning of summer
- Impressive scope of the unusually rapid decrease in the ESI anomalies is clearly depicted by the large area of negative RCI values
- Initial appearance of negative RCI values led the introduction of severe drought in the USDM by more than 4 weeks



**LSM+TIR+MW  
Composite Drought  
Index**

**5 August 2012**

# Development of a Multi-Scale Remote-Sensing Based Framework for Mapping Drought over North America

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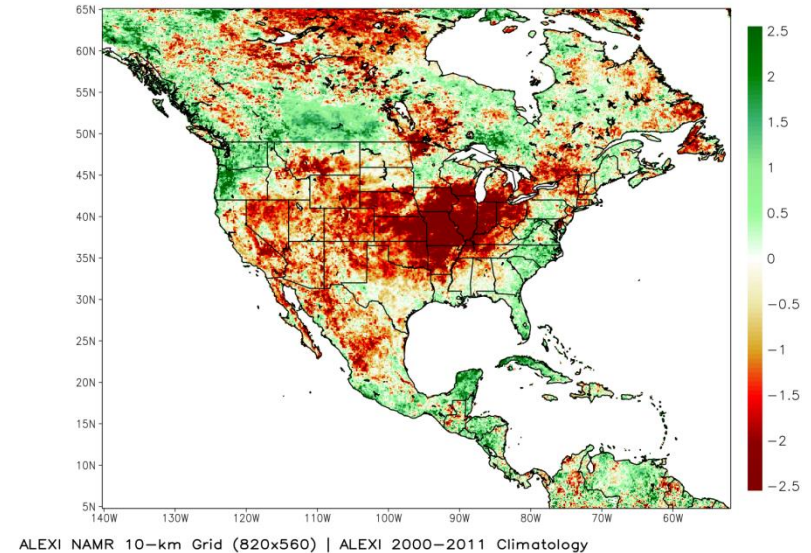
## Highlights:

- To address the need for additional remote sensing-based drought monitoring tools covering North America, the current ESI domain has been expanded to include Canada, Mexico and Central America.

## Relevance to ESD Applied Sciences:

- Access and availability of actionable drought information -- ALEXI ESI provides high-resolution spatial information about drought that is independent of many of the most commonly used drought indicators which rely on accurate specification of precipitation as an inputs
- Drought prediction, assessment, adaptation and mitigation in support of food security and natural resource conservation -- ALEXI ESI can provide information to end-users which can aid in the decision making process of drought mitigation, yield estimation, plant health, and water use (especially in the agricultural sector).

ALEXI Evaporative Stress Index: 12-week Composite  
Initialized : 5 August 2012



## North American Drought Monitor

August 31, 2012

Released: Thursday, September 13, 2012

<http://www.ncdc.noaa.gov/nadm.html>

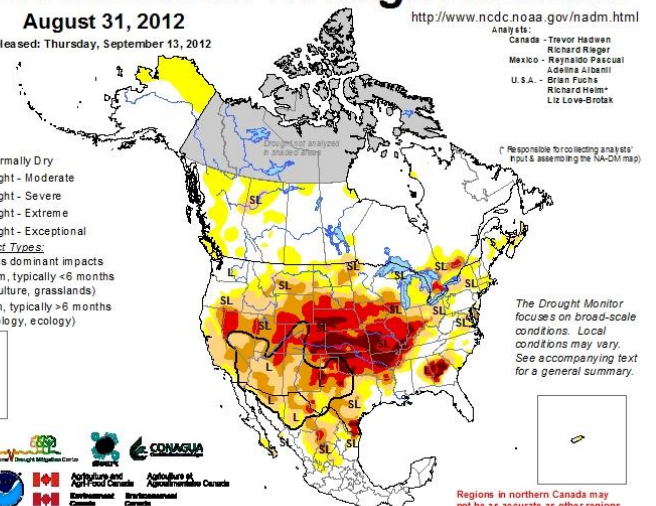
Analysts:  
Canada - Trevor Haden  
Richard Rieger  
Mexico - Reynaldo Pascual  
Adelma Alami  
U.S.A. - Brian Fuchs  
Richard Heim  
Liz Love-Grotok

### Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

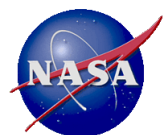
### Drought Impact Types:

- S = Short-Term, typically <6 months  
(e.g. agriculture, grasslands)
- L = Long-Term, typically >6 months  
(e.g. hydrology, ecology)

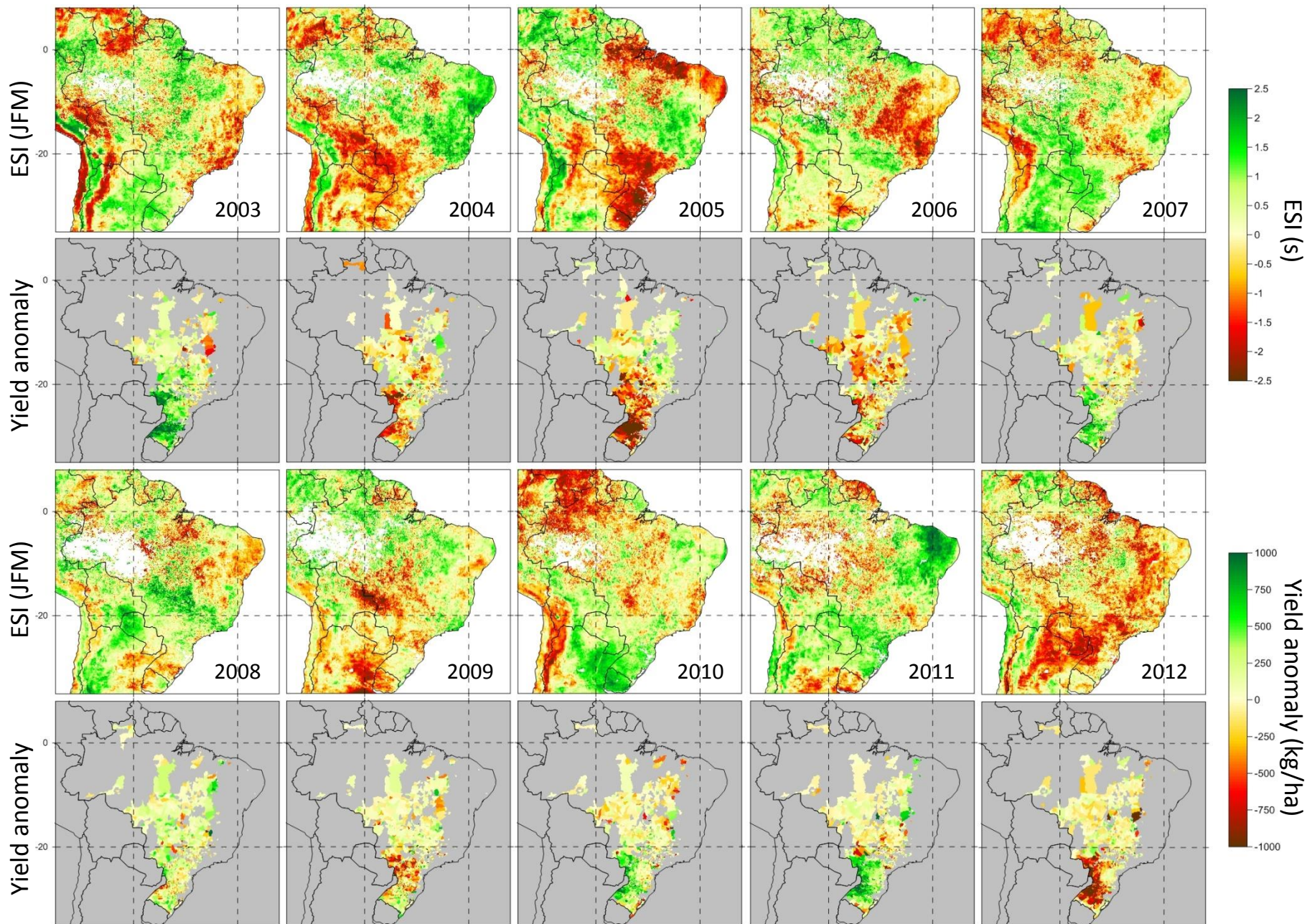


The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text for a general summary.

Regions in northern Canada may not be as accurate as other regions due to limited information.



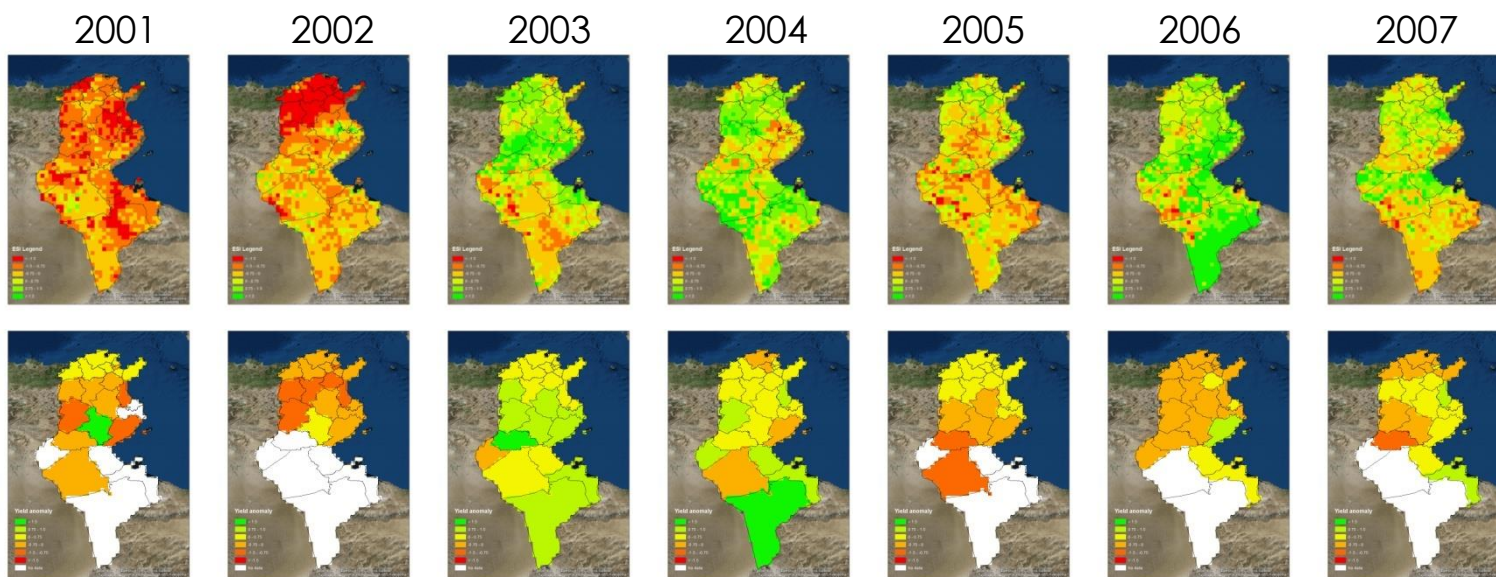
# ANNUAL MUNICIPAL LEVEL SOYBEAN YIELD ANOMALIES



# Yield estimation in Tunisia

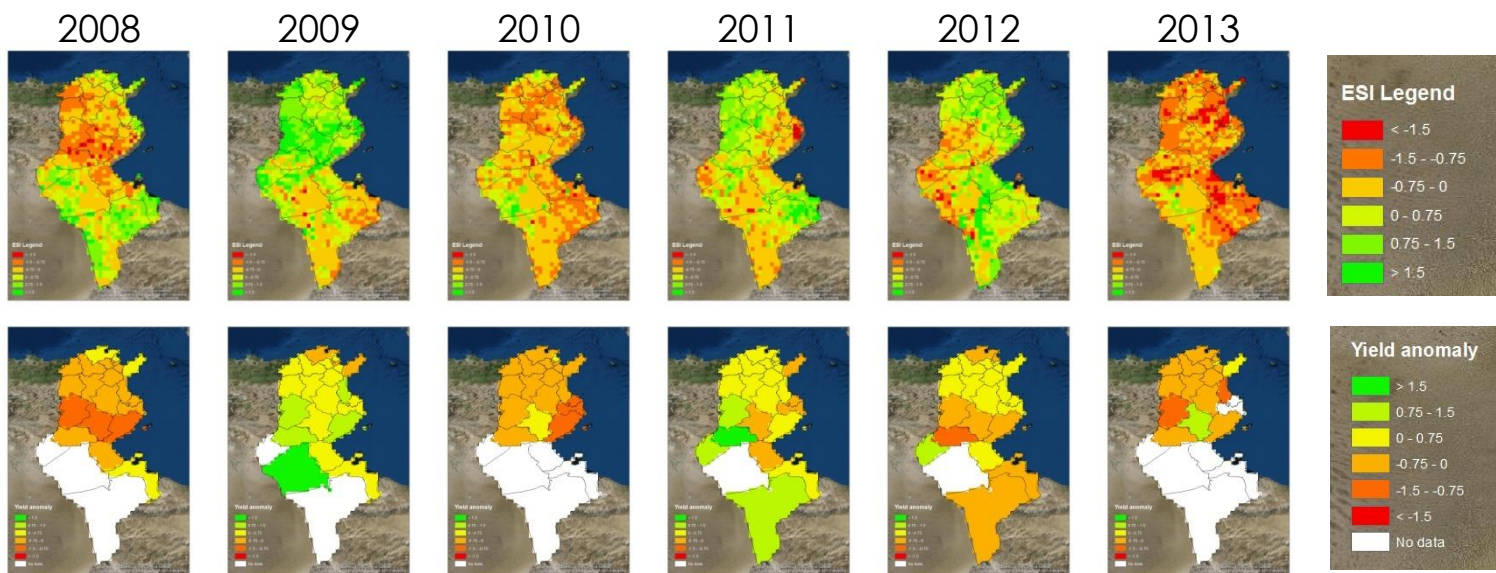
Wheat yield anomaly

ESI



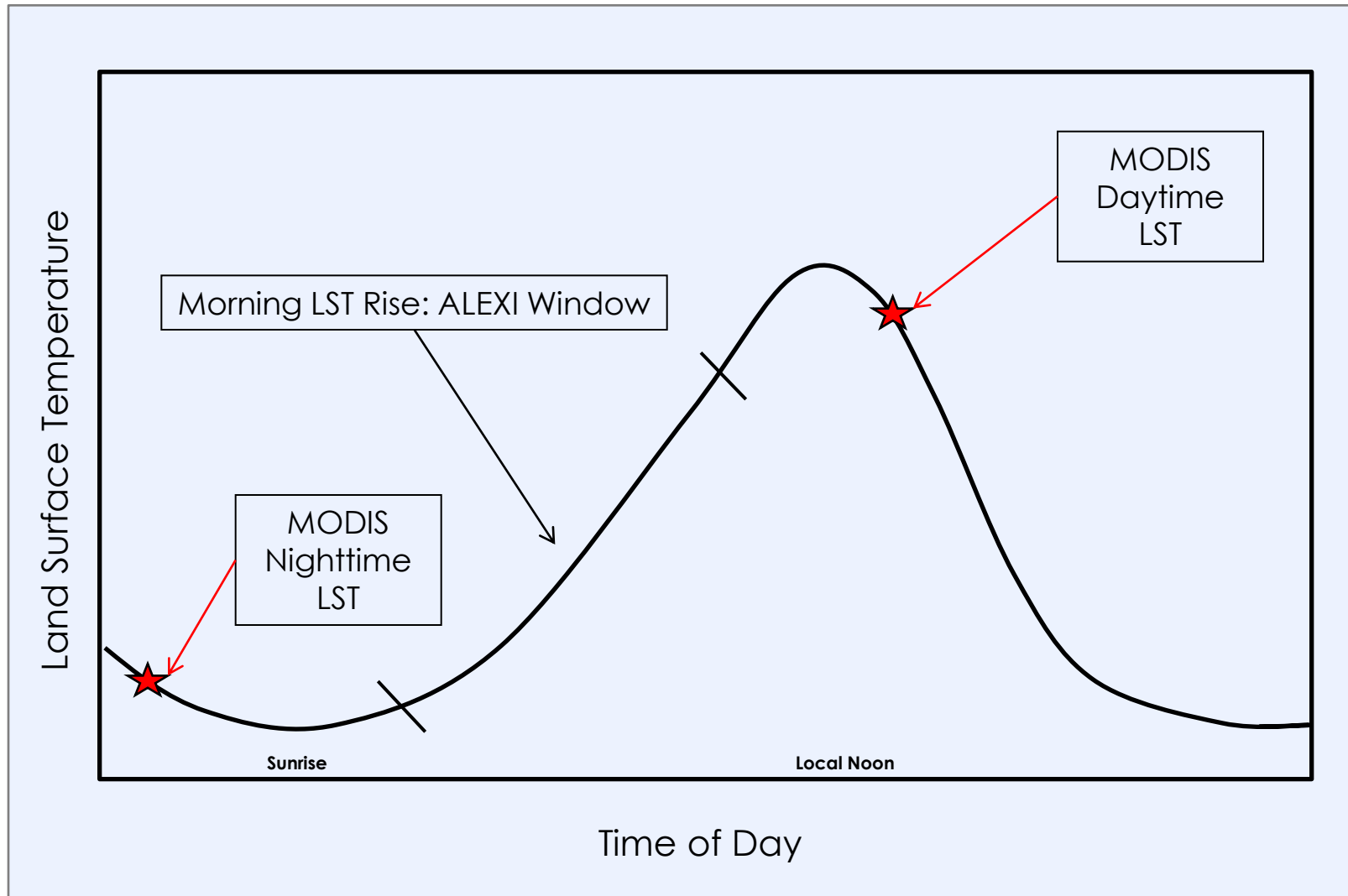
Wheat yield anomaly

ESI

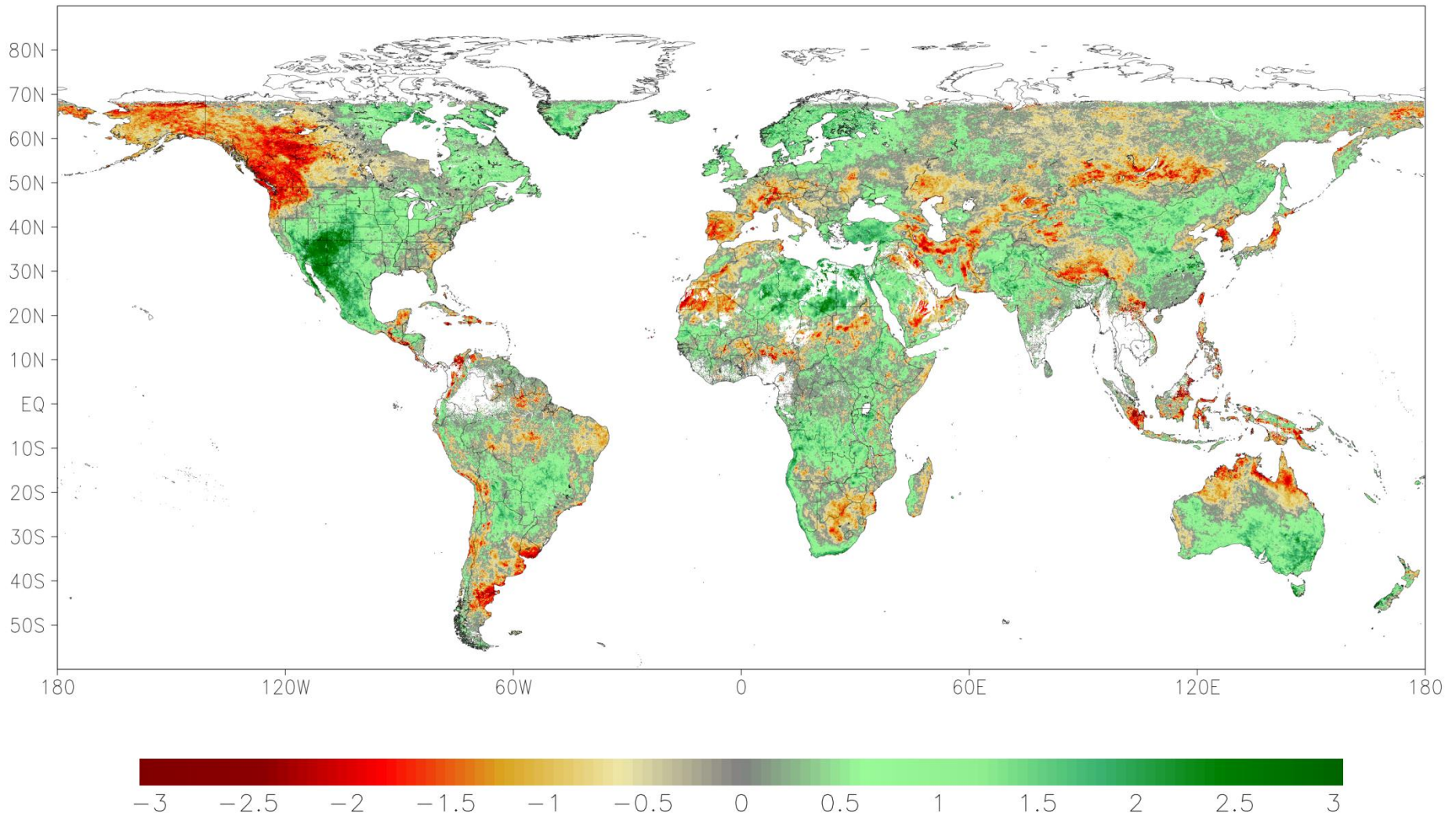


# Supplementing ESI Capabilities with Polar Orbiting Sensors

A technique has been developed and evaluated using GOES data to train a regression model to use day-night LST differences from MODIS to predict the morning LST rise needed by ALEXI. The regression model can provide reasonable estimates of the mid-morning rise in LST (RMSE ~ 5 to 8%) from the twice daily MODIS or VIIRS LST observations.



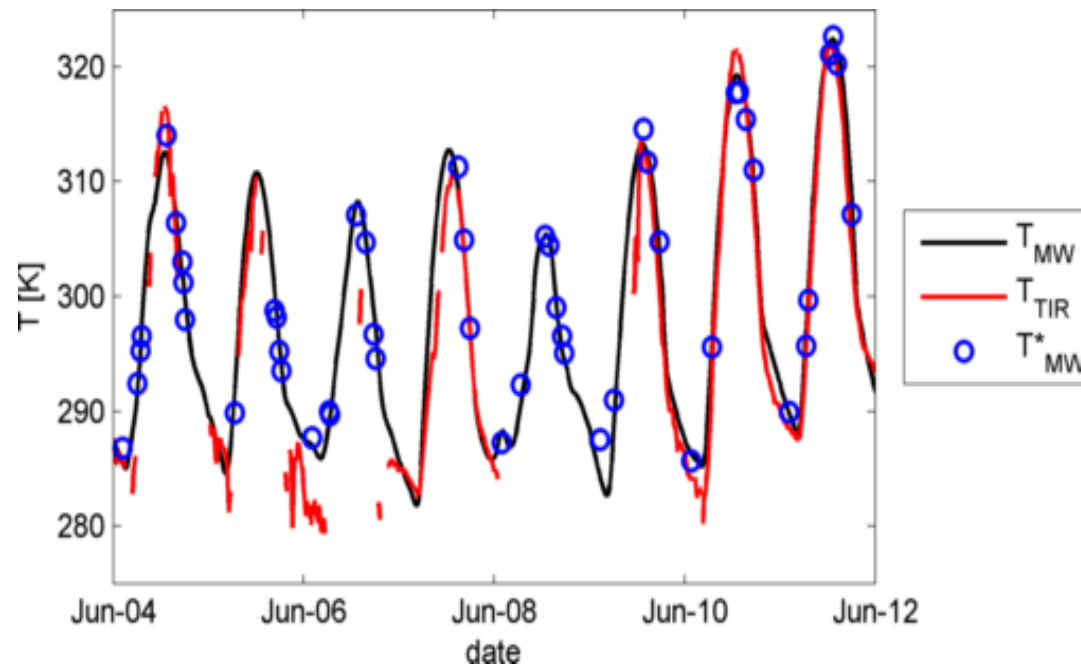
# Evaporative Stress Index — 1 August 2015 — 12-WK



The synergy between TIR and MW observations is further being exploited by the development of LST observations from MW observations (Ka-band).

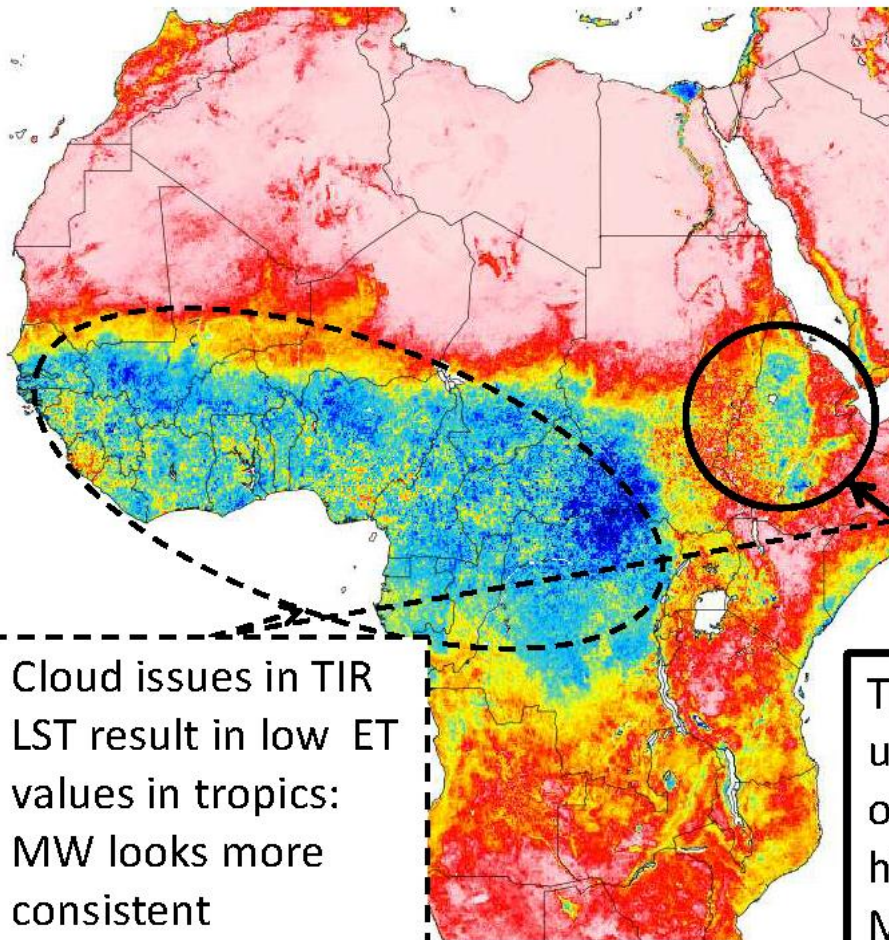
The integration of MW LST into a coupled TIR/MW ALEXI system will allow for retrieval of surface fluxes under cloud cover (where TIR-only retrievals are not possible).

This capability fills in a significant gap in a TIR-only system over tropical equatorial regions where clear-sky retrievals may only be possible 1 to 3 times per month, particularly during the wet season .



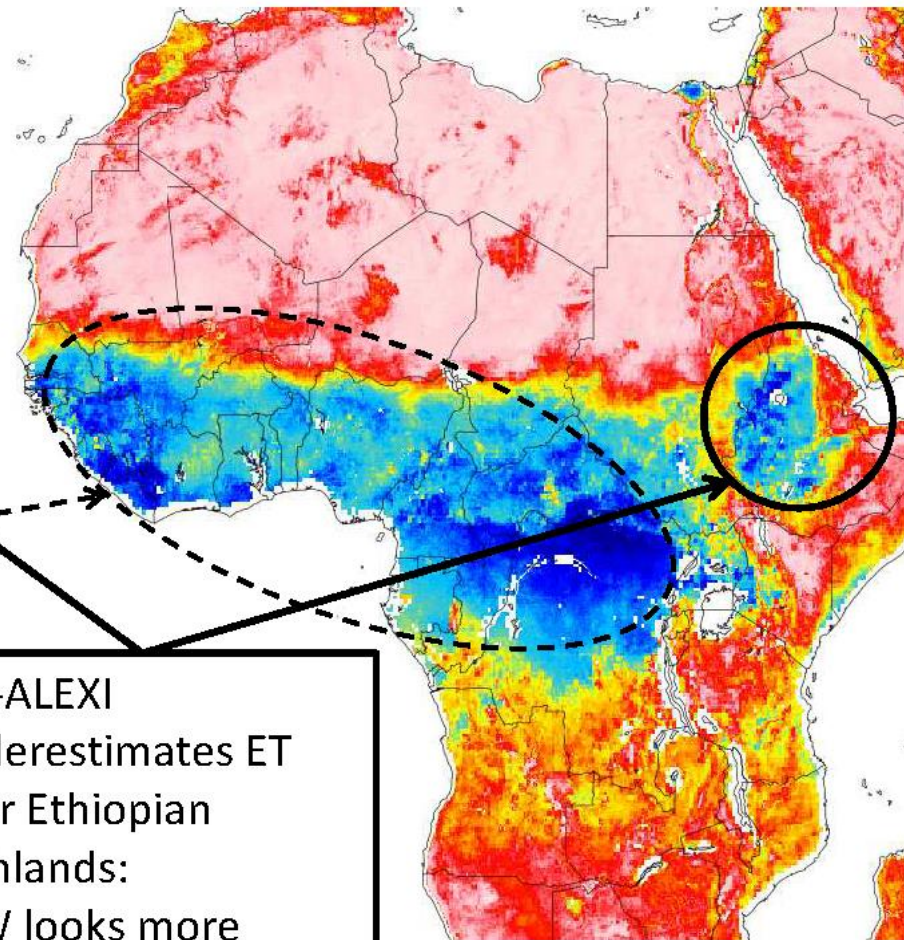
# Cumulative - Clear Sky - Evapotranspiration (mm) Jul/Aug/Sep (2004)

## TIR-ALEXI



Cloud issues in TIR  
LST result in low ET  
values in tropics:  
MW looks more  
consistent

## MW-ALEXI



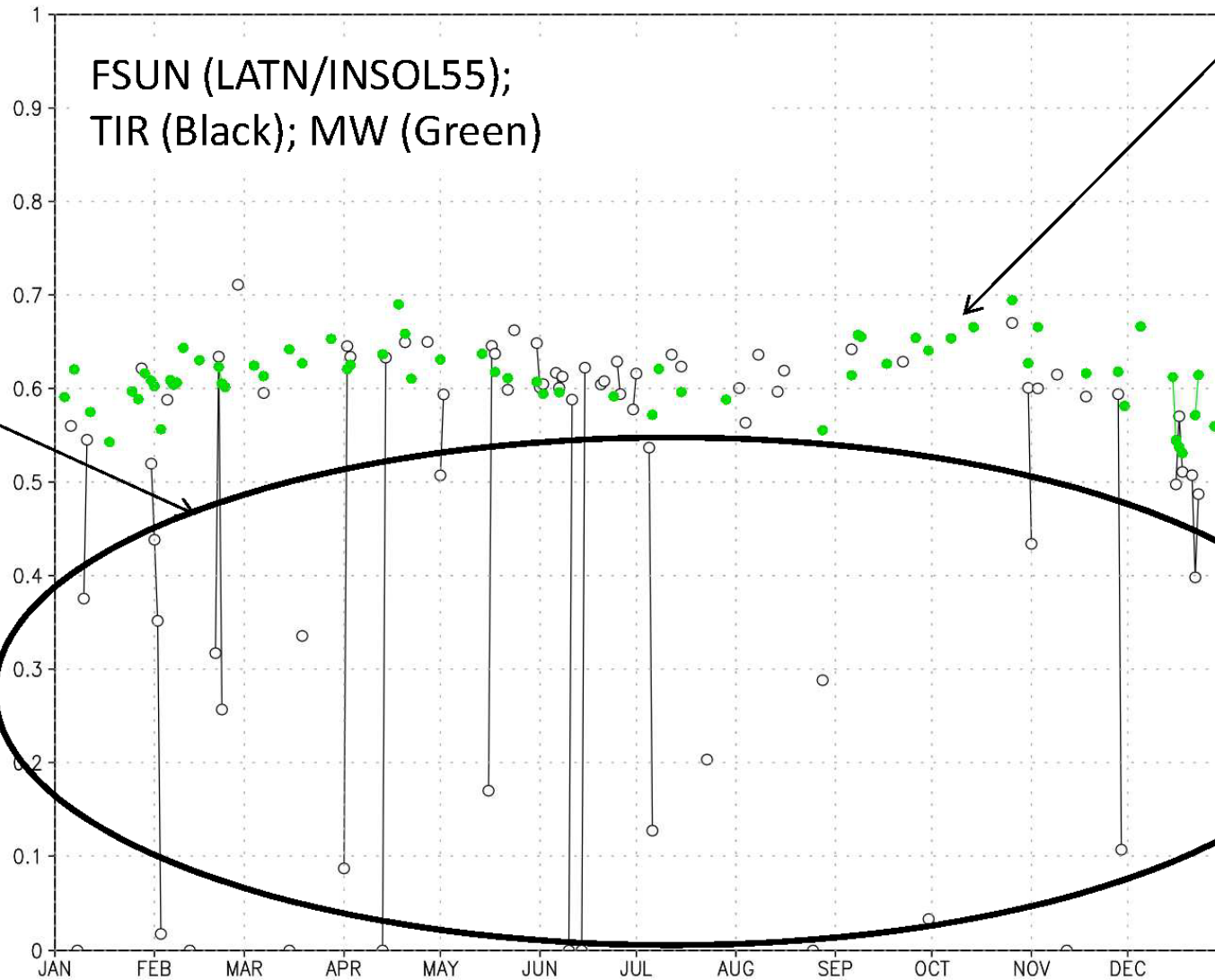
TIR-ALEXI  
underestimates ET  
over Ethiopian  
highlands:  
MW looks more  
realistic

# MW-LST for ET: Clear Sky compared

Lat: 0N

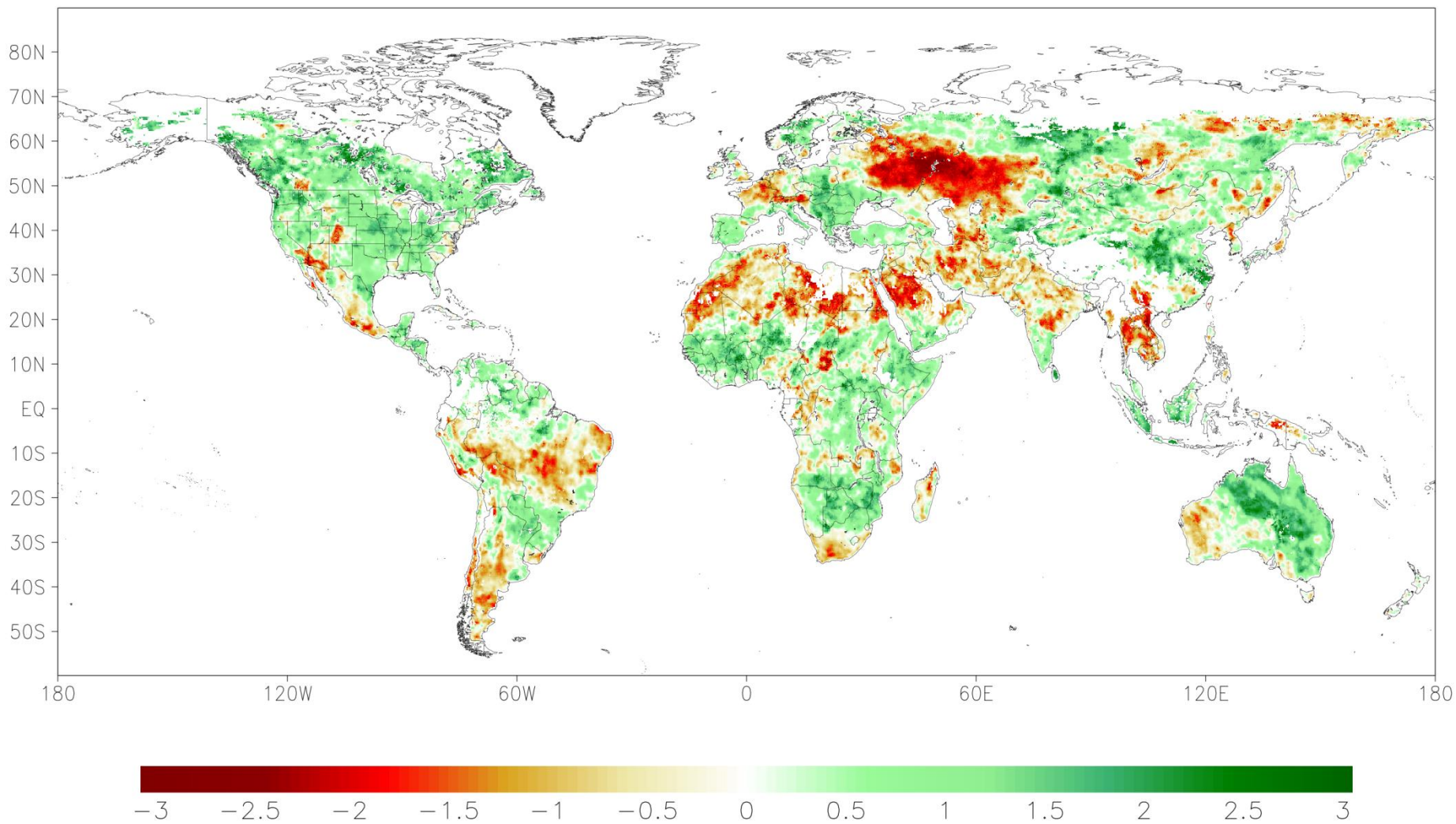
Lon: 20E

Green: Stable MW Signal



TIR  
Cloud  
Issues

# MW 12-WK ESI 5 August 2010



# Advantages

- Diagnostically captures non-precipitation related moisture sources/sinks (irrigation, shallow groundwater, drainage)
- Capacity to map from global to sub-field scales using TIR-based data fusion
- Captures thermal canopy stress signal – agricultural drought monitoring
- Fast response to variable soil evaporation rates (not captured by NDVI alone)

